

2 Analog Television

Throughout the world, there are only two major analog television standards, the 625-line system with a 50 Hz frame rate and the 525-line system with a 60 Hz frame rate. The composite color video-and-blanking signal (CVBS, CCSV) of these systems is transmitted in the following color transmission standards:

- PAL (Phase Alternating Line)
- NTSC (National Television System Committee)
- SECAM (Séquentiel Couleur a Mémoire)

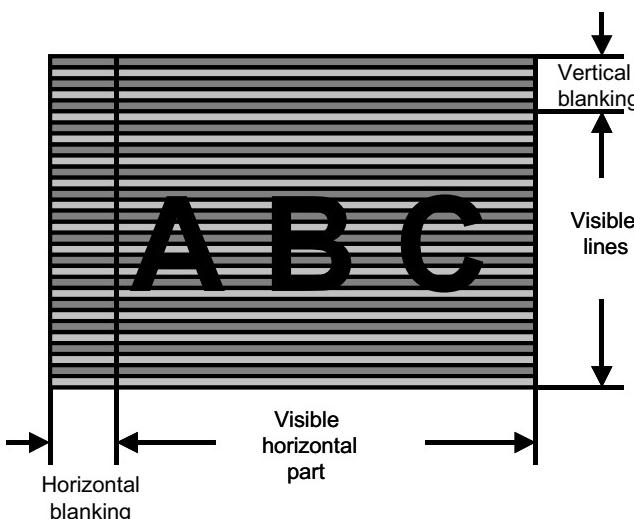


Fig. 2.1. Dividing a frame into lines

PAL, NTSC and SECAM color transmission is possible in 625-line systems and in 525-line systems. However, not all the possible combinations have actually been implemented. The video signal with its composite coding is then modulated onto a carrier, the vision carrier, mostly with negative-going amplitude modulation. It is only in Std. L (France) that positive-

going modulation (sync inside) is used. The first and second sound subcarrier is usually an FM-modulated subcarrier but an amplitude-modulated sound subcarrier is also used (Standard L, France). In Northern Europe, the second sound subcarrier is a digitally modulated NICAM subcarrier. Although the differences between the methods applied in the various countries are only minor, together they result in a multiplicity of standards which are mutually incompatible. The analog television standards are numbered through alphabetically from A to Z and essentially describe the channel frequencies and bandwidths in VHF bands I and III (47 ... 68 MHz, 174 ... 230 MHz) and UHF bands IV and V (470 ... 862MHz); An example is Standard B, G Germany: B =7 MHz VHF, G = 8 MHz UHF.

In the television camera, each field is dissected into a line structure of 625 or 525 lines. Because of the finite beam flyback time in the television receiver, however, a vertical and horizontal blanking interval became necessary and as a result, not all lines are visible but form part of the vertical blanking interval. In a line, too, only a certain part is actually visible. In the 625-line system, 50 lines are blanked out and the number of visible lines is 575. In the 525-line system, between 38 and 42 lines fall into the area of the vertical blanking interval.

To reduce the flickering effect, each frame is divided into two fields combining the even-numbered lines and odd-numbered lines in each case. The fields are transmitted alternately and together they result in a field repetition rate of twice the frame rate. The beginning of a line is marked by the horizontal sync pulse, a pulse which is below the zero volt level in the video signal and has a magnitude of -300 mV.. All the timing in the video signal is referred to the front edge of the sync pulse and there exactly to the 50% point. 10 μ s after the sync pulse falling edge, the active image area in the line begins in the 625-line system. The active image area itself has a length of 52 μ s.

In the matrix in the television camera, the luminance (luminous density) signal (Y signal or black/white signal) is first obtained and converted into a signal having a voltage range from 0 Volt (corresponding to black level) to 700 mV (100% white). The matrix in the television camera also produces the color difference signals from the Red, Green and Blue outputs. It was decided to use color difference signals because, on the one hand, the luminance has to be transmitted separately for reasons of compatibility with black/white television and, on the other hand, color transmission had to conserve bandwidth as effectively as possible. Due to the reduced color resolution of the human eye, it was possible to reduce the bandwidth of the color information. In fact, the color bandwidth is reduced quite significantly compared with the luminance bandwidth: The luminance bandwidth

is between 4.2 MHz (PAL M), 5 MHz (PAL B/G) and 6 MHz (PAL D/K, L) whereas the chrominance bandwidth is only 1.3 MHz in most cases.

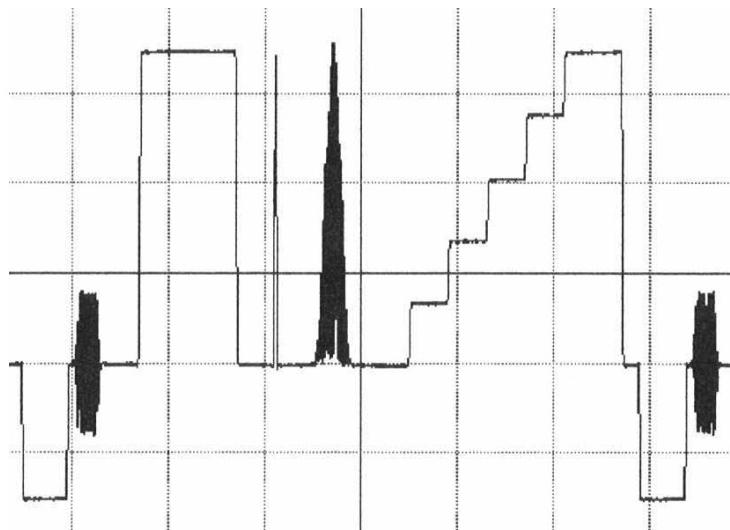


Fig. 2.2. Analog composite video signal (PAL)

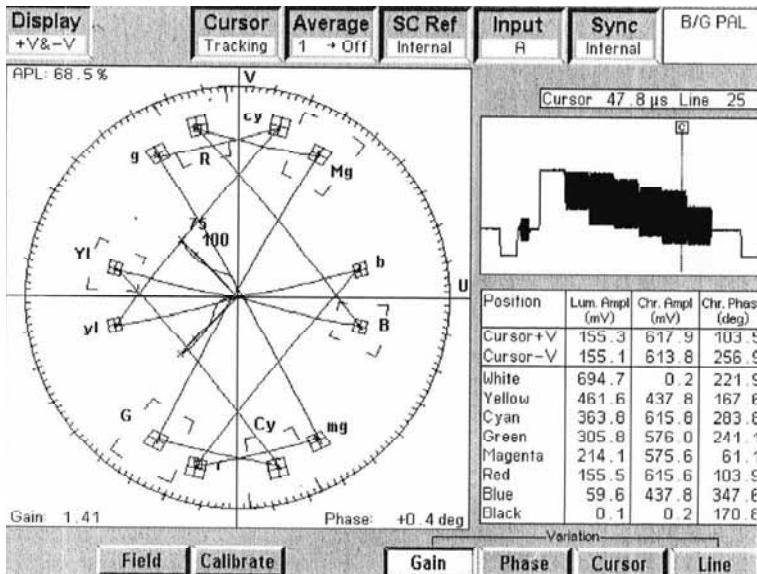


Fig. 2.3. Vector diagram of a composite PAL video signal

In the studio, the color difference signals $U=B-Y$ and $V=R-Y$ are still used directly. For transmission purposes, however, the color difference signals U and V are vector modulated (IQ modulated) onto a color subcarrier in PAL and NTSC. In SECAM, the color information is transmitted frequency-modulated. The common feature of PAL, SECAM and NTSC is that the color information is modulated onto a color subcarrier of a higher frequency which is placed at the upper end of the video frequency band and is simply added to the luminance signal. The frequency of the color subcarrier was selected such that it causes as little interference to the luminance channel as possible. It is frequently impossible, however, to avoid crosstalk between luminance and chrominance and conversely, e.g. if a newsreader is wearing a pinstriped suit. The colored effects which are then visible on the pinstriped pattern are the result of this crosstalk (cross-color or cross-luminance effects).

Vision terminals can have the following video interfaces:

- CVBS, CCSV 75 Ohms 1 V_{PP} (video signal with composite coding)
- RGB components (SCART, Peritel)
- Y/C (separate luminance and chrominance to avoid cross color or cross luminance effects)

In the case of digital television, it is advisable to use an RGB (SCART) connection or a Y/C connection for the cabling between the receiver and the TV monitor in order to achieve optimum picture quality.

In digital television only frames are transmitted, no fields. It is only at the very end of the transmission link that fields are regenerated in the set top box or in the decoder of the IDTV receiver. The original source material, too, is provided in interlaced format which must be taken into account in the compression (field coding).

2.1 Scanning an Original Black/White Picture

At the beginning of the age of television, the pictures were only in “black and white”. The circuit technology available in the 1950s consisted of tube circuits which were relatively large and susceptible to faults and consumed a lot of power. The television technician was still a real repairman and, in the case of a fault, visited his customers carrying his box of vacuum tubes.

Let us look at how such a black/white signal, the “luminance signal”, is produced. Using the letter “A” as an example, its image is filmed by a TV camera which scans it line by line (see Fig. 2.4.). In the early days, this was done by a tube camera in which a light-sensitive layer, onto which the image was projected by optics, was scanned line by line by an electron beam deflected by horizontal and vertical magnetic fields.

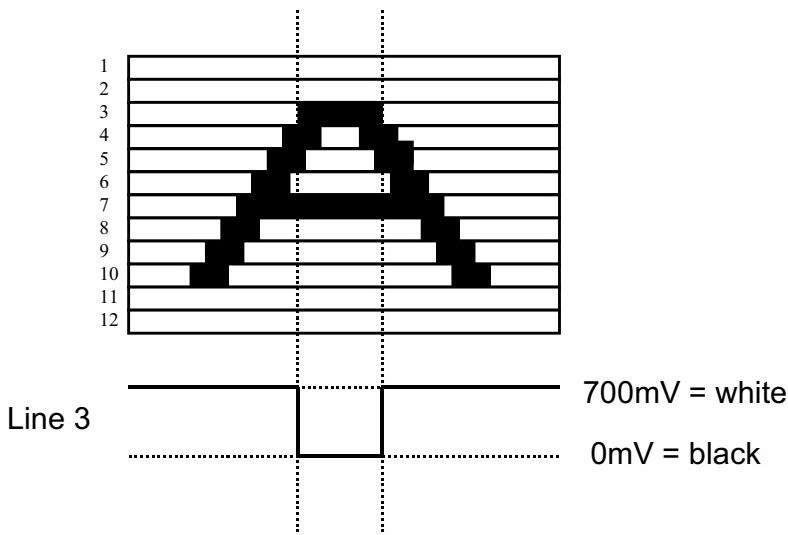


Fig. 2.4. Scanning an original black/white picture

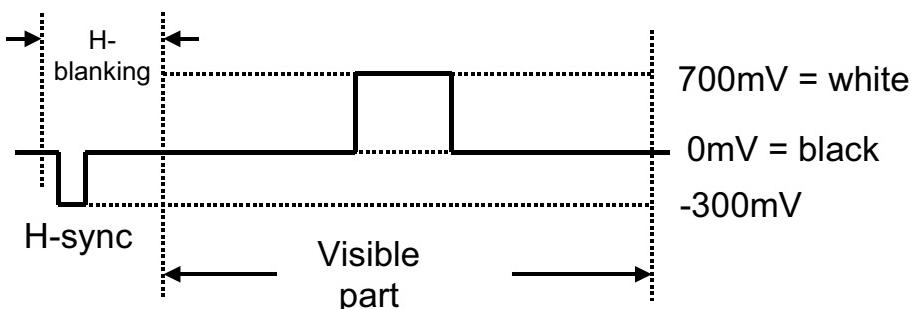


Fig. 2.5. Inserting the horizontal sync pulse

Today, CCD (charge coupled device) chips are universally used in the cameras and the principle of the deflected electron beam is now only pre-

served in TV receivers; and even there the technology is changing to LCD and plasma screens.

The result of scanning the original is the luminance signal where 0 mV corresponds to 100% black and 700 mV is 100% white. The original picture is scanned line by line from top to bottom, resulting in 625 or 525 active lines depending on the TV standard used. However, not all lines are visible. Because of the finite beam flyback time, a vertical blanking interval of up to 50 lines had to be inserted. In the line itself, too, only a certain part represents visible picture content, the reason being the finite flyback time from the right-hand to the left-hand edge of the line which results in the horizontal blanking interval. Fig. 2.4. shows the original to be scanned and Fig. 2.5. shows the associated video signal.

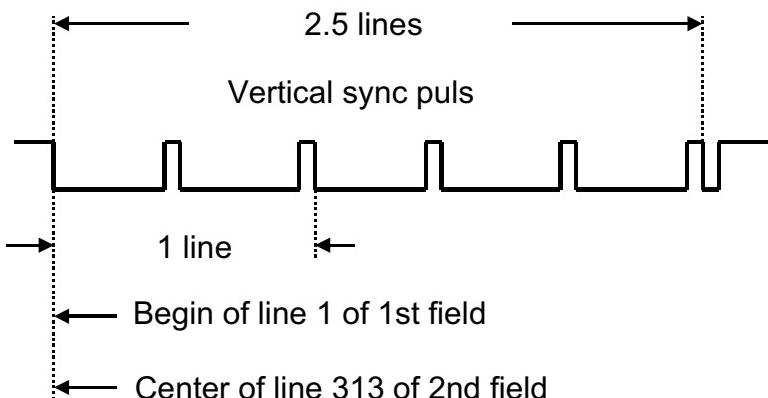


Fig. 2.6. Vertical synchronization pulse

2.2 Horizontal and Vertical Synchronization Pulses

However, it is also necessary to mark the top edge and the bottom edge of the image in some way, in addition to the left-hand and right-hand edges. This is done by means of the horizontal and vertical synchronization pulses. Both types of pulses were created at the beginning of the television age so as to be easily recognizable and distinguishable by the receiver and are located in the blacker than black region below zero volts.

The horizontal sync pulse (Fig. 2.5.) marks the beginning of a line. The beginning is considered to be the 50% value of the front edge of the sync pulse (nominally -150 mV). All the timing within a line is referred to this time. By definition, the active line, which has a length of 52 µs, begins

10 µs after the sync pulse front edge. The sync pulse itself is 4.7 µs long and stays at -300 mV during this time.

At the beginning of television, the capabilities of the restricted processing techniques of the time which, nevertheless, were quite remarkable, had to be sufficient. This is also reflected in the nature of the sync pulses. The horizontal sync pulse (H sync) was designed as a relatively short pulse (appr. 5 µs) whereas the vertical sync pulse (V sync) has a length of 2.5 lines (appr. 160 µs). In a 625-line system, the length of a line including H sync is 64 µs. The V sync pulse can, therefore, be easily distinguished from H sync. The V sync pulse (Fig. 2.6.) is also in the blacker than black region below zero volts and marks the beginning of a frame or field, respectively.

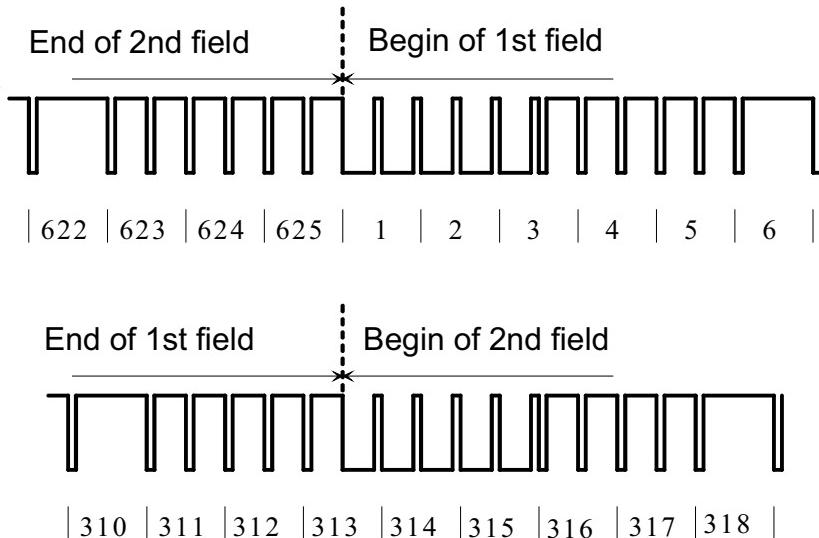


Fig 2.7. Vertical synchronization pulses with pre- and post-equalizing pulses in the 625 line-system

As already mentioned, a frame, which has a frame rate of 25 Hz = 25 frames per second in a 625-line system, is subdivided into 2 fields. This makes it possible to cheat the eye, rendering flickering effects largely invisible. One field is made up of the odd-numbered lines and the other one is made up of the even-numbered lines. They are transmitted alternatingly, resulting in a field rate of 50 Hz in a 625-line system. A frame (beginning of the first field) begins when the V sync pulse goes to the -300 mV level for 2.5 lines at the precise beginning of a line. The second field begins

when the, V sync pulse drops to the -300 mV level for 2.5 lines at the center of line 313.

The first and second field are transmitted interlaced with one another, thus reducing the flickering effect. Because of the limitations of the pulse technology at the beginnings of television, a 2.5-line-long V sync pulse would have caused the line oscillator to lose lock. For this reason, additional pre- and post-equalizing pulses were gated in which contribute to the current appearance of the V sync pulse (Fig. 2.7.). Today's signal processing technology renders these unnecessary.

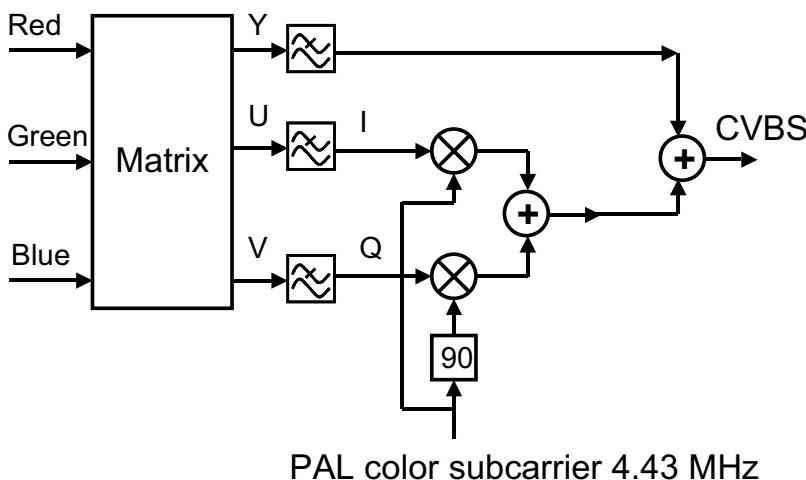


Fig. 2.8. Block diagram of a PAL modulator

2.3 Adding the Color Information

At the beginning of the television age, black/white rendition was adequate because the human eye has its highest resolution and sensitivity in the area of brightness differences and the brain receives its most important information from these. There are many more black/white receptors than color receptors in the retina. But just as in the cinema, television managed the transition from black/white to color because its viewers desired it. Today this is called innovation. When color was added in the sixties, knowledge about the anatomy of the human eye was taken into consideration. With only about 1.3 MHz, color (chrominance) was allowed much less resolution, i.e. bandwidth, than brightness (luminance) which is transmitted with about 5 MHz. At the same time, chrominance is embedded compatibly into

the luminance signal so that a black/white receiver was undisturbed but a color receiver was able to reproduce both color and black/white correctly. If a receiver falls short of these ideals, so-called cross-luminance and cross-color effects are produced.

In all three systems, PAL, SECAM and NTSC, the Red, Green and Blue color components are first acquired in three separate pickup systems (initially tube cameras, now CCD chips) and then supplied to a matrix where the luminance signal is formed as the sum of R + G + B, and the chrominance signal. The chrominance signal consists of two signals, the color difference signals Blue minus luminance and Red minus luminance. However, the luminance signal and the chrominance signal formed must be matrixed, i.e. calculated, provided correctly with the appropriate weighting factors according to the eye's sensitivity, using the following formula

$$Y = 0.3 \bullet R + 0.59 \bullet G + 0.11 \bullet B;$$

$$U = 0.49 \bullet (B-Y);$$

$$V = 0.88 \bullet (R-Y);$$

The luminance signal Y can be used directly for reproduction by a black/white receiver. The two chrominance signals are also transmitted and are used by the color receiver. From Y, U and V it is possible to recover R, G and B. The color information is then available in correspondingly reduced bandwidth, and the luminance information in greater bandwidth ("paintbox principle").

To embed the color information into a CVBS (composite video, blanking and sync) signal intended initially for black/white receivers, a method had to be found which has the fewest possible adverse effects on a black/white receiver, i.e. keeps it free of color information, and at the same time contains all that is necessary for a color receiver.

Two basic methods were chosen, namely embedding the information either by analog amplitude/phase modulation (IQ modulation) as in PAL or NTSC, or by frequency modulation as in SECAM. In PAL and NTSC, the color difference signals are supplied to an IQ modulator with a reduced bandwidth compared to the luminance signal (Fig. 2.8.) The IQ modulator generates a chrominance signal as amplitude/phase modulated color subcarrier, the amplitude of which carries the color saturation and the phase of which carries the hue. An oscilloscope would only show, therefore, if there is color, and how much, but would not identify the hue. This would require a vectorscope which supplies information on both.

In PAL and in NTSC, the color information is modulated onto a color subcarrier which lies within the frequency band of the luminance signal

but is spectrally intermeshed with the latter in such a way that it is not visible in the luminance channel. This is achieved by the appropriate choice of color subcarrier frequency. In PAL (Europe), the color subcarrier frequency was chosen by using the following formula

$$f_{SC} = 283.75 \cdot f_H + 25 \text{ Hz} = 4.43351875 \text{ MHz};$$

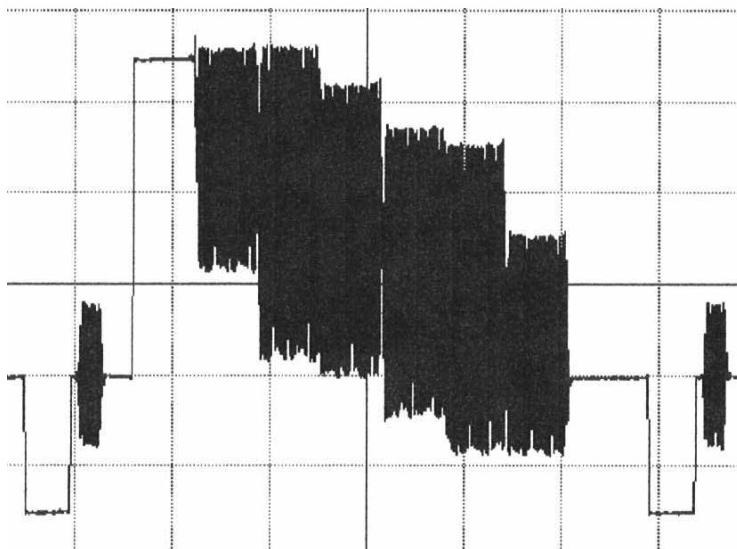


Fig. 2.9. Oscillogram of a CVBS, CCVS (composite color video and sync) signal

In SECAM, the frequency modulated color difference signals are alternately modulated onto two different color subcarriers from line to line. The SECAM process is currently only used in France and in French-speaking countries in North Africa, and also in Greece. Countries of the previous Eastern Block changed from SECAM to PAL in the nineties.

Compared with NTSC, PAL has a great advantage due to its insensitivity to phase distortion because its phase changes from line to line. The color cannot be changed by phase distortion on the transmission path, therefore. NTSC is used in analog television, mainly in North America, where it is sometimes ridiculed as “Never Twice the Same Color” because of the color distortions.

The composite PAL, NTSC or SECAM video signal (Fig. 2.9.) is generated by mixing the black/white signal, the sync information and the chrominance signal and is now called a CCVS (Composite Color, Video and

Sync) signal. Fig. 2.9. shows the CCVS signal of a color bar signal. The color burst can be seen clearly. It is used for conveying the reference phase of the color subcarrier to the receiver so that its color oscillator can lock to it.

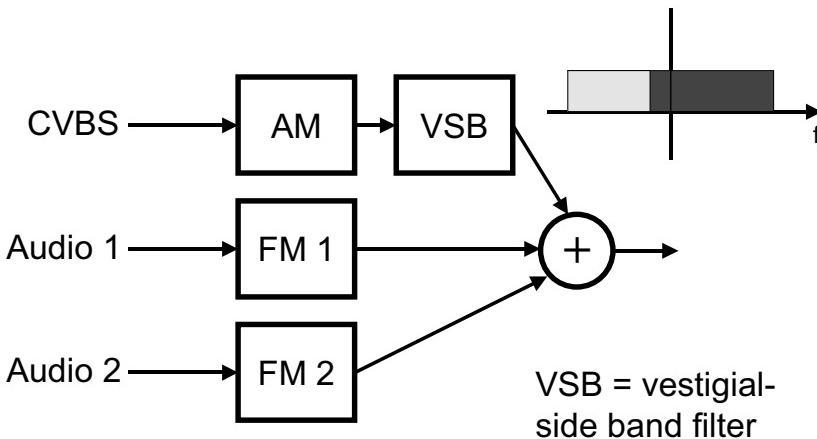


Fig. 2.10. Principle of a TV modulator for analog terrestrial TV and analog TV broadband cable

2.4 Transmission Methods

Analog television is disseminated over three transmission paths which are: terrestrial transmission paths, via satellite and by broadband cable. The priority given to any particular transmission path depends greatly on the countries and regions concerned. In Germany, the traditional analog “antenna TV” has currently only a minor status with fewer than 10%, this term being used mainly by the viewers themselves whereas the actual technical term is “terrestrial TV”. The reason for this is the good coverage by satellite and cable, and more programs. This will change when DVB-T is introduced as has already become apparent in some regions.

Transmission of analog television via terrestrial and satellite paths will shrivel away into insignificance within a few years. Whether this will also be true of broadband cable cannot yet be predicted.

In the terrestrial transmission of analog TV signals, and that by cable, the modulation method used is amplitude modulation, in most cases with

negative modulation. Positive modulation is only used in the French Standard L.

The sound subcarriers are frequency modulated in most cases. To save bandwidth, the vision carrier is VSB-AM (vestigial sideband amplitude modulation) modulated, i.e. a part of the spectrum is suppressed by band-pass filtering. The principle is shown in Fig. 2.10. and 2.11. Because of the nonlinearities and the low signal/noise ratio on the transmission link, frequency modulation is used in satellite transmission.

Since these analog transmission paths are losing more and more in significance, they will not be discussed in greater detail in this book and the reader is referred to the appropriate literature, instead.

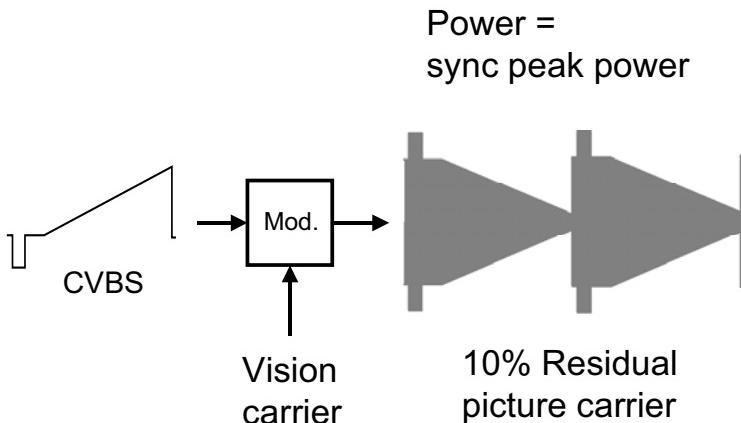


Fig. 2.11. Vision modulator

2.5 Distortion and Interference

Over the entire transmission link, an analog video signal is subjected to influences which have a direct effect on its quality and are immediately visible in most cases. These distortions and interferences can be roughly grouped in the following categories:

- Linear distortion (amplitude and phase distortion)
- Non-linear distortion
- Noise

- Interference
- Intermodulation

Linear distortion is caused by passive electronic components. The amplitude or group delay is no longer constant over a certain frequency range which is 0 ... 5 MHz in the case of video. Parts of the relevant frequency range are distorted to a greater or lesser extent, depending on the characteristic of the transmission link involved. As a result, certain signal components of the video signal are rounded. The worst effect is rounding of the sync pulses which leads to synchronization problems in the TV receiver such as, e.g. horizontal "pulling" or "rolling" of the picture from top to bottom. These terms have been known since the early days of television.

Changing of heads from field to field produces similar effects at the top edge of the picture with some older videorecorders, the picture is "pulling".

These effects have become relatively rare thanks to modern receiver technology and relatively good transmission techniques. In the active picture area, linear distortion manifests itself either as lack of definition, ringing, optical distortion or displacement of the color picture with respect to the luminance picture.

Nonlinear distortion can be grouped into

- Static nonlinearity
- Differential gain
- Differential phase

With non-linear distortion, neither the gray steps nor the color subcarrier are reproduced correctly in amplitude and phase. Non-linear distortion is caused by active components (transmitter tubes, transistors) in the transmission link. However, they become only visible ultimately when many processes are added together since the human eye is very tolerant in this respect. Putting it another way: "Although this isn't the right gray step, who is to know?". And in color television this effect is less prominent, in any case, because of the way in which color is transmitted, particularly with PAL.

One of the most visible effects is the influence of noise-like disturbances. These are simply produced by superimposition of the ever-present gaussian noise, the level of which is only a question of its separation from the useful signal level. I.e., if the signal level is too low, noise becomes visible. The level of thermal noise can be determined in a simple way via the Boltzmann constant, the bandwidth of the useful channel and the normal

ambient temperature and is thus almost a fixed constant. Noise is immediately visible in the analog video signal which is the great difference compared with digital television.

Intermodulation products and interference are also very obvious in the video signal and have a very disturbing effect, forming moiré patterns in the picture. These effects are the result of heterodyning of the video signal with an interfering product either from an adjacent channel or interferers entering the useful spectrum directly from the environment. This type of interference is the one most visible and thus also causes the greatest disturbance in the overall impression of the picture. It is also most apparent in cable television because of its multichannel nature.

2.6 Signals in the Vertical Blanking Interval

Since the middle of the seventies, the vertical blanking interval, which was originally used for the vertical flyback, is no longer only "empty" or "black". At first, so-called VITS (vertical insertion test signals), or test lines, were inserted there which could be used for assessing the quality of the analog video signal. In addition, teletext and the data line can be found there. Test lines were and are used for monitoring the transmission quality of a TV transmission link or section virtually on-line without having to isolate the link. These test lines contain test signals which can be used for identifying the causes of faults.

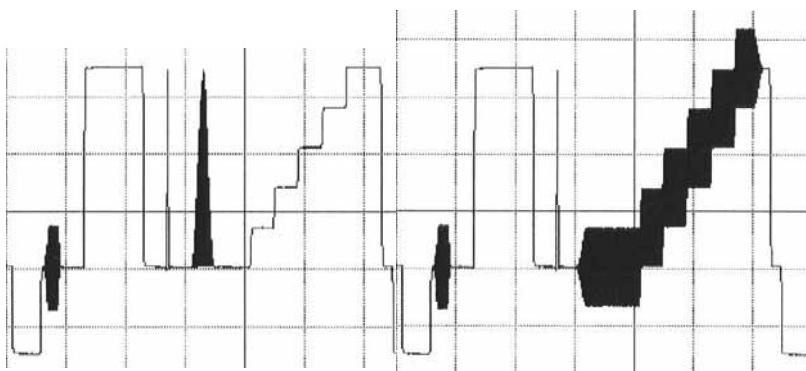


Fig. 2.12. CCIR 17 and 330 test lines

Test line "CCIR 17" (now ITU 17, on the left in Fig. 2.12.) begins with the so-called white pulse (bar) and is used as technical voltage reference

for 100% white. Its nominal amplitude is 700 mV. The "roof" of the white pulse is 10 μ s long and should be flat and without overshoots. This is followed by the 2T pulse which is a so-called \cos^2 pulse with a half-amplitude period of $2T = 2 \cdot 100 \text{ ns} = 200 \text{ ns}$. The main components of its spectrum extend to the end of the luminance channel of 5 MHz. It reacts very sensitively to amplitude response and group delay distortion from 0 ... 5 MHz and can thus be used for assessing linear distortion both visually and by measurement. The next pulse is a 20T pulse, a \cos^2 pulse with superimposed color subcarrier and with a half-amplitude period of $20T = 20 \cdot 100 \text{ ns} = 2 \mu\text{s}$. It clearly shows linear distortion of the color channel with respect to the luminance channel.

Linear distortion of the color channel with respect to the luminance channel is

- Differential gain of the color channel with respect to the luminance channel
- Luminance-chrominance delay caused by group delay

Non-linear distortion can be easily identified by means of the 5-step gray scale. All five steps must have identical height. If they do not have equal height due to nonlinearities, this is called static nonlinearity (luminance nonlinearity). In test line 330, the gray scale is replaced by a staircase on which the color subcarrier is superimposed. This can be used for identifying non-linear effects on the color subcarrier such as differential amplitude and phase. The color bursts superimposed on the staircase should all be ideally of the same amplitude and must not have a phase discontinuity at the transition points of the steps.

Teletext is well known by now (Fig. 2.13. and 2.14.). It is a data service offered in analog television. The data rate is about 6.9 Mbit/s, but only in the area of the lines really used in the vertical blanking interval. In actual fact, the data rate is much lower. In each teletext line, 40 useful characters are transmitted. A teletext page consists of 40 characters times 24 lines. If the entire vertical blanking interval were to be used, just short of one teletext page could be transmitted per field. Teletext is transmitted in NRZ (non-return-to-zero) code. A teletext line begins with the 16-bit-long run-in, a sequence of 10101010... for synchronizing the phase of the teletext decoder in the receiver. This is followed by the framing code. This hexadecimal number 0xE4 marks the beginning of the active teletext. After the magazine and line number, the 40 characters of a line of the teletext are transmitted. One teletext page consists of 24 text lines.

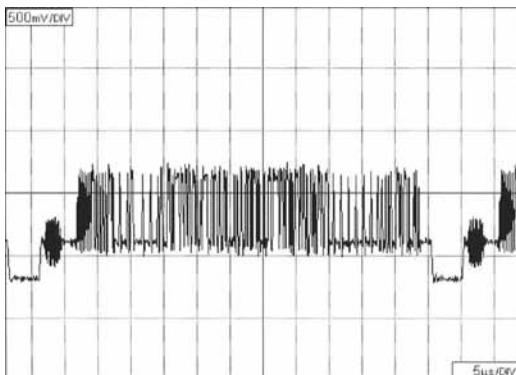


Fig. 2.13. Teletext line

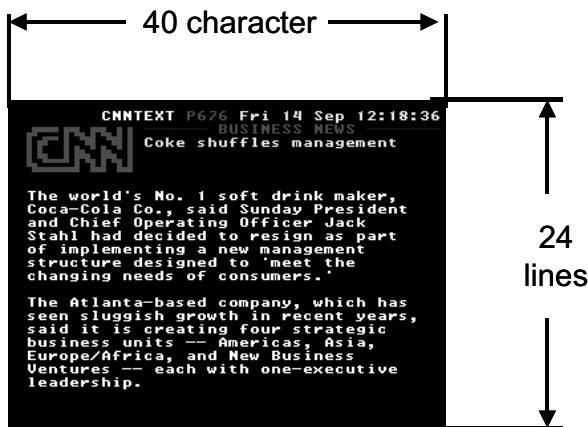


Fig. 2.14. Teletext page

The most important teletext parameters are as follows:

- Non-return-to-zero code
- Data rate: $444 \times 15625 \text{ kbit/s} = 6.9375 \text{ Mbit/s}$
- Error protection: Even parity
- Characters per line: 40
- Lines per teletext page: 24

The data line (e.g. line 16 and corresponding line in the second field, Fig. 2.15.) is used for transmitting control information, signaling and,

among other things, the VPS (video program system) data for controlling video recorders. In detail, the data line is used for transmitting the following data:

- Byte 1: Run-in 10101010
- Byte 2: Start code 01011101
- Byte 3: Source ID
- Byte 4: Serial ASCII text transmission (source)
- Byte 5: Mono/stereo/dual sound
- Byte 6: Video content ID
- Byte 7: Serial ASCII text transmission
- Byte 8: Remote control (routing)
- Byte 9: Remote control (routing)
- Byte 10: Remote control
- Byte 11 to 14: Video program system (VPS)
- Byte 15: Reserved

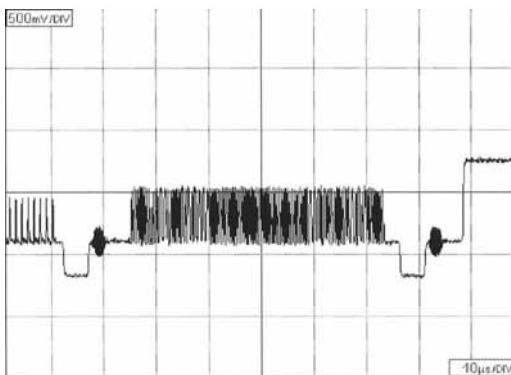


Fig. 2.15. Data line (mostly line 16 in the vertical blanking interval)

The VPS bytes contain the following information:

- Day (5 bits)
- Month (4 bits)
- Hour (5 bits)
- Minute (6 bits) = virtual starting time of the program
- Country ID (4 bits)
- Program source 11) (6 bits)

The transmission parameters of the data line are:

- Line: 16/329
- Code: Return-to-zero code
- Data rate: 2.5 Mbit/s
- Level: 500 mV
- Data: 15 bytes per line

According to DVB, these signals from the vertical blanking interval are partially regenerated in the receiver to retain compatibility with analog television. The test line signals, however, are no longer provided.

2.7 Measurements on Analog Video Signals

Analog video signals have been measured since the beginning of the TV age, initially with simple oscilloscopes and vectorscopes and later with ever more elaborate video analyzers, the latest models of which were digital (Fig. 2.22.). These video measurements are intended to identify the distortions in the analog video signal. The following test parameters are determined with the aid of test lines:

- White bar amplitude
- Sync amplitude
- Burst amplitude
- Tilt on the white bar
- 2T pulse amplitude
- 2T K factor
- Luminance-chrominance amplitude on the 20T pulse
- Luminance-chrominance delay on the 20T pulse
- Static nonlinearity on the grayscale
- Differential gain on the grayscale with color subcarrier
- Differential phase on the grayscale with color subcarrier
- Weighted and unweighted luminance signal/noise ratio
- Hum

In addition, an analog TV test receiver also provides information on:

- Vision carrier level

- Sound carrier level
- Deviation of the sound carriers
- Frequencies of vision and sound carriers
- Residual picture carrier
- ICPM (Incidental phase modulation)

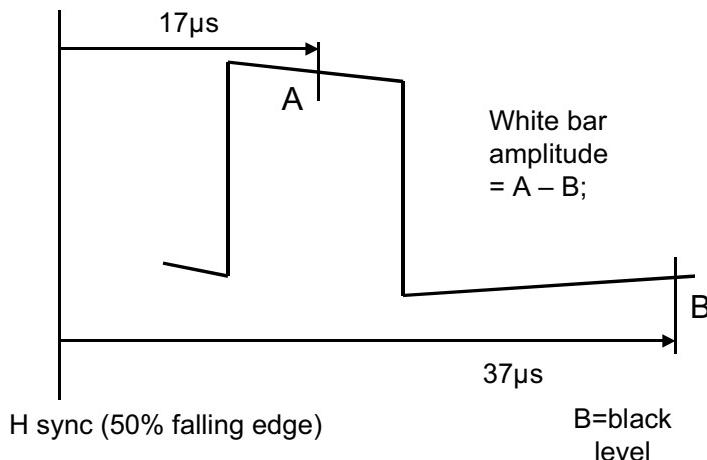


Fig. 2.16. Measuring the white bar amplitude

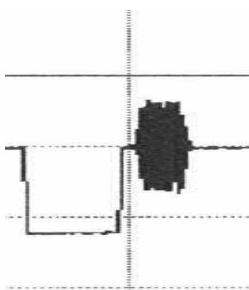


Fig. 2.17. Sync pulse and burst

The most important parameter to be measured on an analog TV signal is the white bar amplitude which is measured as shown in Fig. 2.16. In the worst case, the white bar can also be quite rounded due to linear distortions, as indicated in the figure. The sync amplitude (s. Fig. 2.17.) is used as

voltage reference in the terminals and is of special importance for this reason. The sync amplitude is nominally 300 mV below black. The 50% value of the falling edge of the sync pulse is considered to be the timing reference in the analog video signal. The burst (s. Fig. 2.17.) is used as voltage and phase reference for the color subcarrier. Its amplitude is $300 \text{ mV}_{\text{PP}}$. In practice, amplitude distortions of the burst have little influence on the picture quality.

Linear distortion leads to tilt on the white bar (Fig. 2.18.). This is also an important test parameter. To measure it, the white bar is sampled at the beginning and at the end and the difference is calculated which is then related to the white pulse amplitude.

The 2T pulse reacts sensitively to linear distortion in the entire transmission channel of relevance. Fig. 2.19. shows the undistorted 2T pulse on the left. It has been used as test signal for identifying linear distortion since the seventies. A 2T pulse altered by linear distortion is also shown on the right in Fig. 2.19. If the distortion of the 2T pulse is symmetric, it is caused by amplitude response errors. If the 2T pulse appears to be unsymmetric, then group delay errors are involved (non-linear phase response).

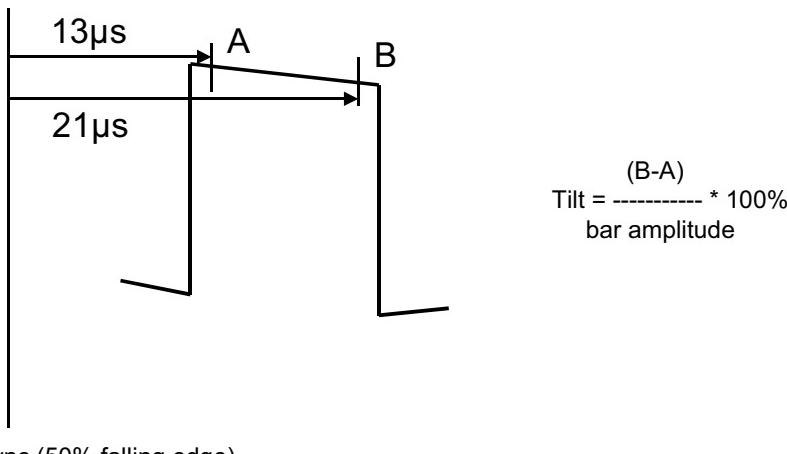


Fig. 2.18. Tilt on the white bar

The 20T pulse (Fig. 2.20., center) was created especially for measurements in the color channel. It reacts immediately to differences between luminance and chrominance. Special attention must be paid to the bottom of the 20T pulse. It should be straight, without any type of indentation. In

the ideal case, the 20T pulse, like the 2T pulse, should have the same magnitude as the white pulse (700 mV nominal).

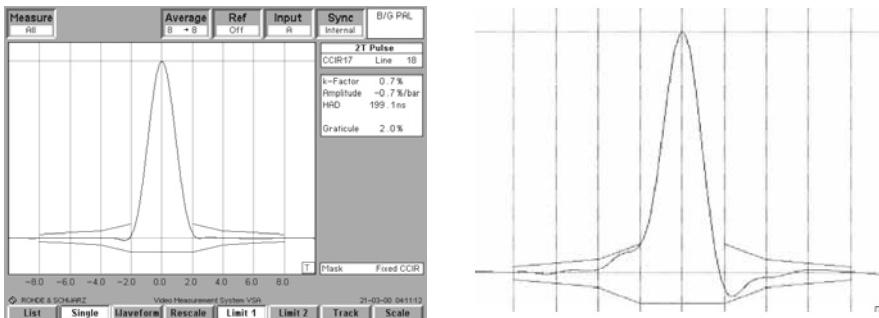


Fig. 2.19. Undistorted (left) and distorted (right) 2T pulse



Fig. 2.20. Linearly distorted white pulse, 2T pulse and 20T pulse

Nonlinearities distort the video signal in dependence on modulation. This can be shown best on staircase signals. To this end, the gray scale and the staircase with color subcarrier were introduced as test signal, the steps simply being of different size in the presence of nonlinearities. Noise and intermodulation can be verified best in a black line (Fig. 2.21.). In most cases, line 22 was kept free of information for this purpose but this is not necessarily so any longer, either, since it carries teletext in most cases. To measure these effects, it is only necessary to look for an empty line suitable for this purpose among the 625 or 525 lines and this differs from program to program.

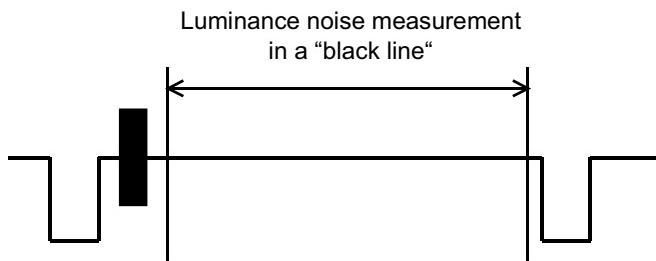


Fig. 2.21. Luminance noise measurement in a "black line"

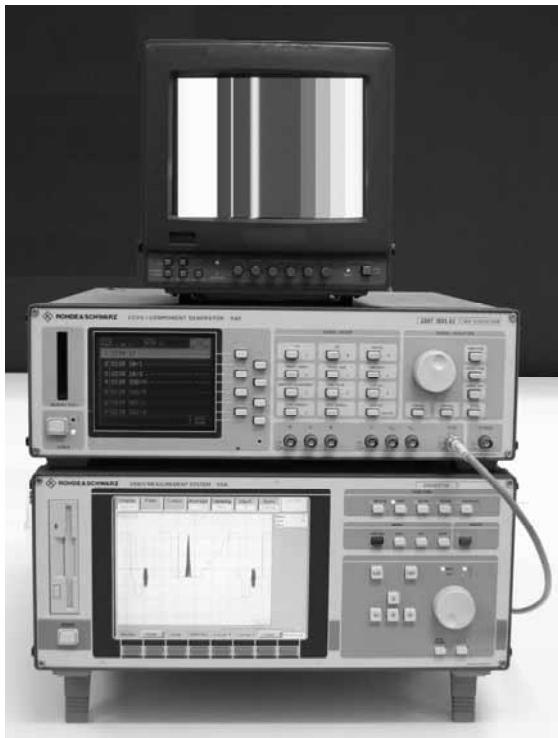


Fig. 2.22. Analog video test and measurement equipment: video test signal generator and video analyzer (Rohde&Schwarz SAF and VSA)

In digital television, test line testing now only makes sense for assessing the beginning (studio equipment) and the end (receiver) of the transmis-

sion link. In between - on the actual transmission link - nothing happens that can be verified by this means. The corresponding measurements on the digital transmission links will be described in detail in the respective chapters.

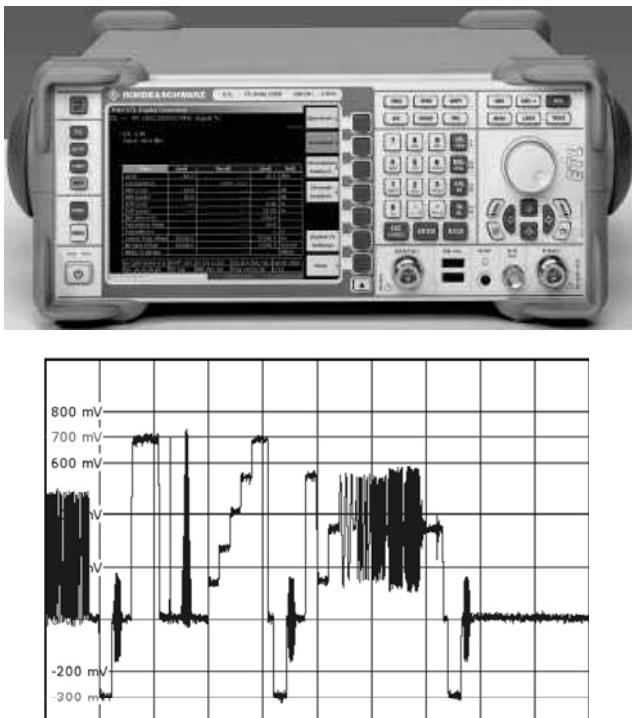


Fig. 2.23. TV Analyzer Rohde&Schwarz ETL for analog and digital TV measurements; ETL offers spectrum analyzer functionality and analog and digital TV measurements

2.8 Analog and Digital TV in a Broadband Cable Network

There is still both analog and digital TV and FM radio in a broadband cable network. That means analog TV and analog TV measurements are still a topic today.

Fig. 2.23. and 2.24. shows a current example of a mix of analog FM audio and analog and digital TV channels in a broadband cable network (year 2008, Germany and Austria).

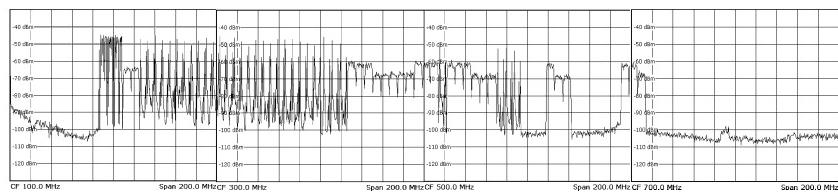


Fig. 2.24. Analog and digital broadband cable channels (example Munich, Germany, 0 ... 800 MHz)

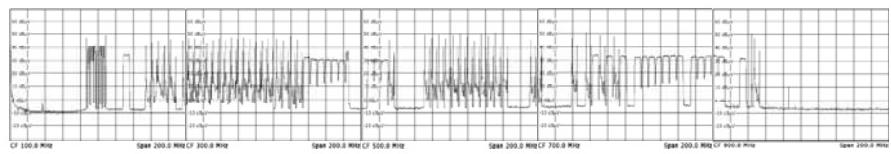


Fig. 2.25. Analog and digital broadband cable channels (example Klagenfurt, Austria, 0 ... 1000 MHz)

Bibliography: [MÄUSL3], [MÄUSL5], [VSA], [FISCHER6], [ETL]